

SERVICE MANUAL
MODEL C16 COMPUTER
OCT. 1984 PN-314001-03

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C16 PRODUCT SPECIFICATION

MEMORY

16K RAM Standard

ROM

32K ROM Standard (includes operating system and BASIC interpreter).

MICROPROCESSOR

7501/8501 Microprocessor with a two speed clock (.89 or 1.76 MHz).

DISPLAY

40 Columns x 25 lines of text.

COLORS

121 Colors (15 colors; 8 luminance levels and Black).

CHARACTERS

Upper & lower case letters, numerals and symbols. Reverse and flashing characters. All PET graphic characters.

DISPLAY MODES

Text characters. High resolution graphics. Split screen text/high resolution graphics. MultiColor graphics. Split screen/multi-color graphics.

RESOLUTION

320 x 200 Pixels

SOUND

2 Tone generators or 1 Tone and 1 noise generator.

VOLUME

8 Volume levels

KEYBOARD

Full size/full stroke C64 style design.

KEYS

66 Keys total. 4 Cursor control keys. 4 Function keys (up to 8 user defined/programmable functions possible). Color control keys. HELP key. Upper and lower case character set.

INPUTS/OUTPUTS

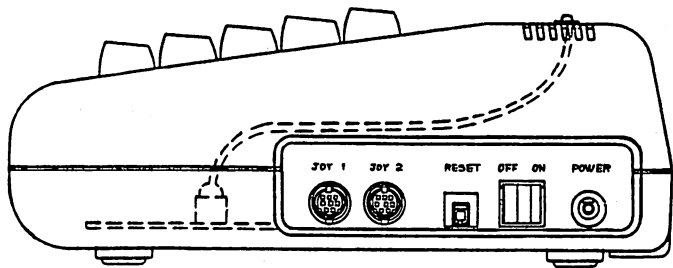
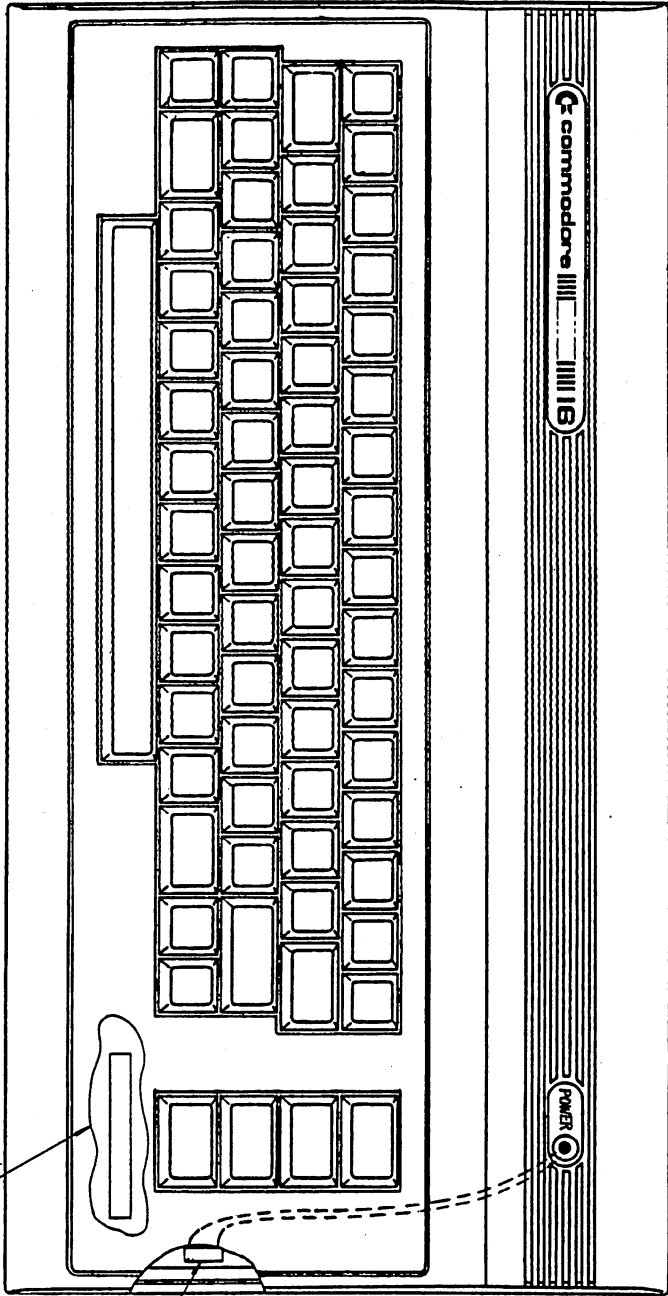
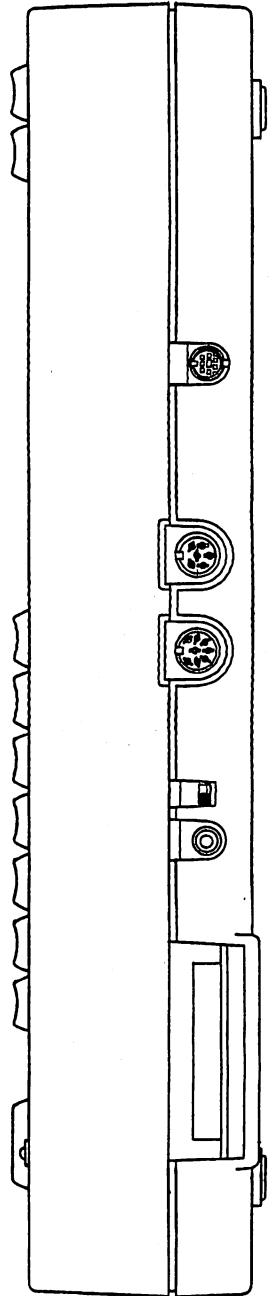
Serial port. ROM cartridge and parallel disk drive port. 2 Joystick ports. C1531 Cassette drive interface port. RF Output — channel 3 or 4. Video output — composite/chrominance/luminance, audio input/output. Power supply input.

FEATURES

Built-in BASIC 3.5 — over 100 commands, statements and functions. Built-in Machine Language Monitor — over 12 commands. Built-in graphics and sound commands. Screen window capability. Extended screen editor.

PERIPHERALS

C1541 Disk drive, C1551 Fast Disk Drive, C1531 Datasette, MPS 802 Dot matrix printer, MPS 803 Dot matrix printer, DPS 1101 Daisy wheel printer, C1520 Plotter/Printer, C1802/1803 Color monitor, C1702 Color monitor.



20-PIN CONNECTOR
FROM KEYBOARD
CN2 REF.

3 PIN CONNECTOR
FROM LED LAMP
CN9 REF.

C-16 Casework Identification

PARTS LIST
C-16

TOP CASE ASSY

Top Case	C 251813-01
Keyboard, 66 Key	C 251798-01
LED Plate	C 326160-02
Nameplate	C 251794-01
Lamp Holder Set	C 903820-03
LED Assembly	C 1001039-01

BOTTOM CASE ASSY

Bottom Case	C 251790-01
Foot, Self-Adhesive	C 950157-04
PCB Shield Plate, top	C 251795-01
PCB Shield Plate, bottom	C 251796-01
PCB Insulation Sheet	C 251797-01

ACCESSORIES

Users Manual	C 251799-01
Power Supply	C 251539
RF Cable	C 326189-02
Switch Box	C 904778-01

C — Indicates Commodore Stock Part

PARTS LIST — C-16 PCB ASSEMBLY #250443-01

PLEASE NOTE: Commodore part numbers are provided for reference only and do not indicate the availability of parts from Commodore. Industry standard parts (Resistors, Capacitors, Connectors) should be secured locally. Approved cross-reference for TTL chips, Transistors, etc., will be available in manual form through the Service Department in November of 1984. Unique or non-standard parts will be stocked by Commodore and are indicated on the parts list by a "C".

INTEGRATED CIRCUITS				RESISTORS (Continued)			
U1	IC 7360 VSLI, Text Display (TED)	C 251535-01		R5	18K	R20	47K
	Sub: IC8360	C 251535-02		R6	1.5K	R21	100K
U2	IC 7501 Custom Microprocessor	C 251536-01		R7	470K	R23	10K
U3	IC 23128 ROM TED Basic	C 318006-01		R8	1K	R24	1K
U4	IC 23128 ROM TED Kernal	C 318005-05		R9	12K	R25	100K
	Sub: IC23128	C 318005-04		R10	Wound 20K	R26	240K
U5,U6	IC D-RAM 16 x 4	251538-02			5W,10%	R27	240K
U7,U8	IC 74LS257	901521-57		R11	10K	R28	1K
U9	IC 7406	901522-06		R12	3.3K	R29	100K
U10	IC 555	901523-01		R13	470K	R102	330K
U11	IC 74LS125	901521-20		R14	470K		
U12	IC 74LS02	901521-21		RESISTOR PACK			
U13	IC 6529B Single Port Interface	C 251640-03		RP1	1K 6 PIN 0.19W 2%	902441-22	
U14	IC 74LS139	901521-18		RP2	3.3K 6 PIN 0.19W 2%	902441-29	
U15	IC 74LS175	901521-34		RP3	68K 8 PIN	326149-06	
U16	IC 7700-010 PLA	C 251641-02		RP4	68K 8 PIN	326149-06	
TRANSISTORS				RP5	3.3K 6 PIN 0.19W 2%	902441-29	
Q1	2SC 1815	902693-01		CAPACITORS			
Q2	2SC 1815			C1	Elect 1 μ F 25V	900100-32	
Q3	2SC 1815			C2	Elect 47 μ F 25V	900100-33	
Q5	2SD 880	902694-01		C3	Elect 10 μ F 25V	900100-01	
DIODES				C4	Elect 10 μ F 25V	900100-01	
D1—D10	IN914B FORMING	251819-16		C5	Ceramic 0.1 μ F 25V	251075-06	
	Sub:			C6	Ceramic 0.1 μ F 25V	251075-06	
	15953(3) FORMING	251819-07		C7	Ceramic 0.22 μ F 25V	251075-07	
D11	IN4001	900750-01		C8	Ceramic 0.22 μ F 25V	251075-07	
D12	ZENER RD 6.8EB	900927-01		C10	Ceramic 0.1 μ F 25V	251075-06	
	Sub: ZENER IN754A	900927-02		C11	Ceramic 0.1 μ F 25V	251075-06	
RESISTORS — All values are in ohms-1/4 W				C12	Ceramic 22 pF 50V	251070-14	
5%, Carbon Comp - Forming				C13	Ceramic 220 pF 50V	251071-26	
Typ, unless noted otherwise.				C14	Ceramic 150 pF 50V	251071-24	
R1	10K	R3	470K	C15	Ceramic 0.01 pF 25V	251075-01	
R2	4.7K	R4	220K	C16	Elect 10 μ F 25V	900100-01	
				C17	Elect 1 μ F 16V	900100-16	
				C18	Elect 10 μ F 25V	900100-01	
				C19	Elect 10 μ F 25V	900100-01	
				C20	Ceramic 0.01 μ F 25V	251075-01	
				C21	Ceramic 0.1 μ F 25V	251075-06	
				C22	Ceramic 0.1 μ F 25V	251075-06	

C — Commodore Stock Item

PART LIST — C16 PCB ASSEMBLY #250443-01 (Continued)

CAPACITORS (Continued)			MISCELLANEOUS (Continued)		
C23	Ceramic	470 pF 50V 251071-30	M1	Cartridge Guide	C 310171-01
C24	Ceramic	470 pF 50V 251071-30		Connector Panel	251791-01
C25	Ceramic	470 pF 50V 250171-30		RF Modulator	C 251844-01
C26	Ceramic	0.1 μ F 25V 251075-06		Ferrite Bead	325563-01
C28	Ceramic	0.1 μ F 25V 251075-06			
C30	Ceramic	0.1 μ F 25V 251075-06			
C31	Elect	10 μ F 25V 900100-01			
C32	Ceramic	0.1 μ F 25V 251075-06			
C33	Ceramic	0.1 μ F 25V 251075-06			
C34	Ceramic	0.1 μ F 25V 251075-06			
C200	Ceramic	.22 μ F 25V 251075-07			
CT1	Capacitor, Trimmer	251029-02	EM1-5	EMI Filter	251842-01
MISCELLANEOUS			CONNECTORS		
Y1	Crystal 14.31818 MHZ —		CN1	Connector, 50 PIN Female Edge,	
	CL = 32 pF	251081-03		Expan. Gold Plated	251630-02
	Sub:		CN2	Header Pin, 20 PIN, Keyboard	
	Crystal 14.31818 MHZ	251081-01			903364-01
L1	Coil Inductor 1.2 μ H	325570-01	CN3	Connector, 7 PIN MINI DIN,	
L3	Line Filter	251701-01		Cassette	C 251616-01
SW1	Switch, Rocker (PC Mount)		CN4	Connector, 8 PIN MINI DIN,	
		C 251587-01		Joy 0 Joy 1	C 251259-01
SW2	Switch, Push Button	C 251260-01	CN5	Connector, 8 PIN MINI DIN,	
				Joy 0 Joy 1	C 251259-01
VR1	Voltage Regulator 7805	901527-02	CN6	Connector, 8 PIN DIN,	
F1	Fuse, Normal BLOW 250V 1.5A			Audio/Video	C 325573-01
		903556-18	CN7	Connector, 6 PIN DIN,	
F1	Fuse, Clip	906102-01		Serial Bus	C 903361-01
			CN8	Connector Jack, DC Power,	
				Power	C 251263-01
			CN9	Header Assembly, 3 PIN, LED	
					903332-03

C — Commodore Stock Item

PIN ASSIGNMENT

A2	1	48	-A3
A1	2	47	-A4
A0	3	46	-A5
VDD	4	45	-A6
CS0	5	44	-A7
CS1	6	43	-A8
R/W	7	42	-A9
IRQ	8	41	-A10
MUX	9	40	-A11
RAS	10	39	-A12
CAS	11	38	-A13
$\phi 0$	12	37	-A14
COLOR	13	36	-A15
CLK IN	14	35	-AEC
K0	15	34	-BA
K1	16	33	-SND
K2	17	32	-D7
K3	18	31	-D6
K4	19	30	-D5
K5	20	29	-D4
K6	21	28	-D3
K7	22	27	-D2
SYNC	23	26	-D1
VSS	24	25	-D0

**U1-251535-01
VLSI, TEXT DISPLAY
(TED)**

PIN ASSIGNMENT

ϕ OIN	1	40	-RES
RDY	2	39	-R/W
IRQ	3	38	-D0
AEC	4	37	-D1
VCC	5	36	-D2
A0	6	35	-D3
A1	7	34	-D4
A2	8	33	-D5
A3	9	32	-D6
A4	10	31	-D7
A5	11	30	-P0
A6	12	29	-P1
A7	13	28	-P2
A8	14	27	-P3
A9	15	26	-P4
A10	16	25	-P5
A11	17	24	-P6
A12	18	23	-GATE IN
A13	19	22	-A15
GND	20	21	-A14

**U2-251536-01
CUSTOM MICROPROCESSOR**

PIN ASSIGNMENT

ENABLE	1	18	-VSS
D0	2	17	-D3
D1	3	16	-CAS
WE	4	15	-D2
RAS	5	14	-A0
A6	6	13	-A1
A5	7	12	-A2
A4	8	11	-A3
VDD	9	10	-A7

U5-U6 16 X 4 D-RAM

PIN CONFIGURATION

NC	1	28	-VCC
A12	2	27	-CS ₃
A7	3	26	-A13
A6	4	25	-A8
A5	5	24	-A9
A4	6	23	-A11
A3	7	22	-CS ₁
A2	8	21	-A10
A1	9	20	-CS ₂
A0	10	19	-D8
D1	11	18	-D7
D2	12	17	-D6
D3	13	16	-D5
GND	14	15	-D4

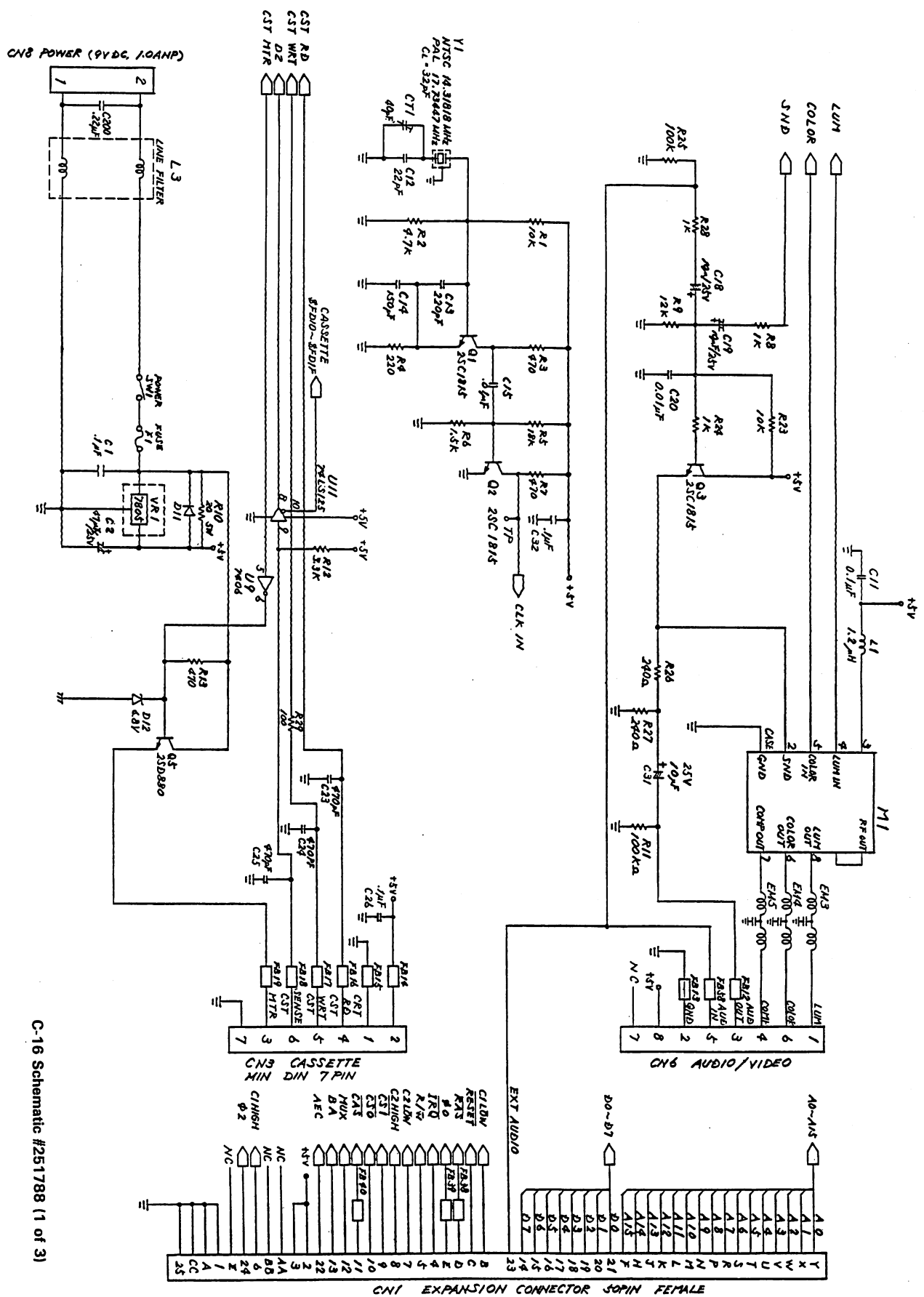
**U3-318006-01
ROM TED - BASIC**

PIN CONFIGURATION

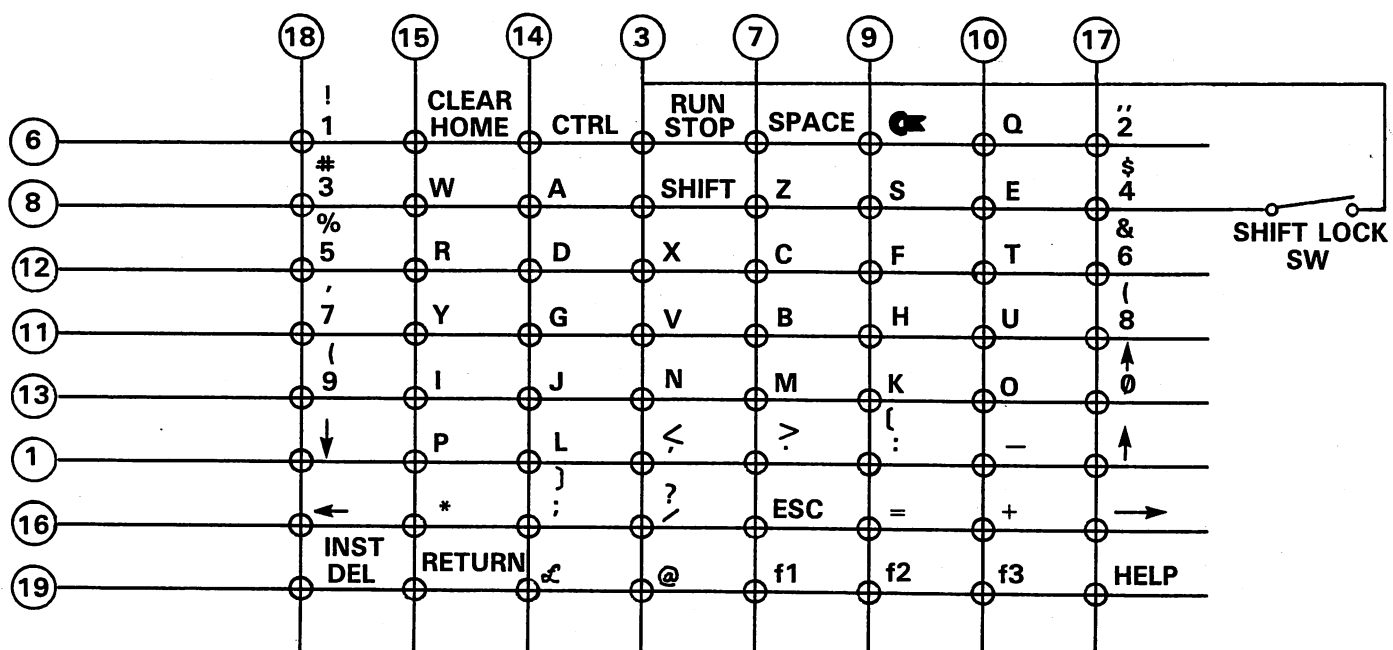
NC	1	28	-VCC
A12	2	27	-CS ₃
A7	3	26	-A13
A6	4	25	-A8
A5	5	24	-A9
A4	6	23	-A11
A3	7	22	-CS ₁
A2	8	21	-A10
A1	9	20	-CS ₂
A0	10	19	-D8
D1	11	18	-D7
D2	12	17	-D6
D3	13	16	-D5
GND	14	15	-D4

**U4-318005-04
ROM TED - KERNAL**

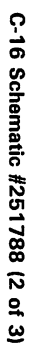
PART NO.	SUGGESTED SOURCE OF SUPPLY	VENDOR PART NO.	ACCESS TIME FROM RAS TRAC (ns)	RANDOM READ/ WRITE CYCLE TIME TRACT (ns)
251538-02	TEXAS INSTRUMENT	TMS4416-15	150	260
-02	FUJITSU	MB81416-15	150	260
-02	MITSUBISHI	M5M4416P-15	150	260
-02	HITACHI	HM48416AP-15	150	260



C-16 Schematic #251788 (1 of 3)



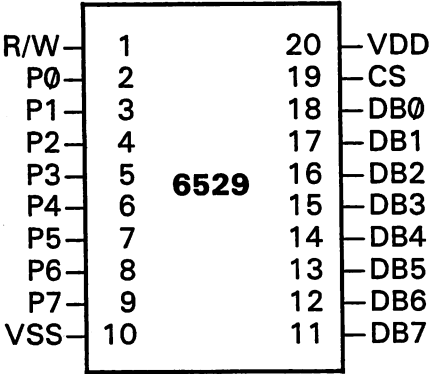
**C16
KEYBOARD MATRIX**



CS	R/W	D0-D7
L	L	DATA BUS TO PORT
L	H	PORT TO DATA BUS
H	X	ISOLATION

L = LOW LEVEL
 H = HIGH LEVEL
 X = IRREVELANT

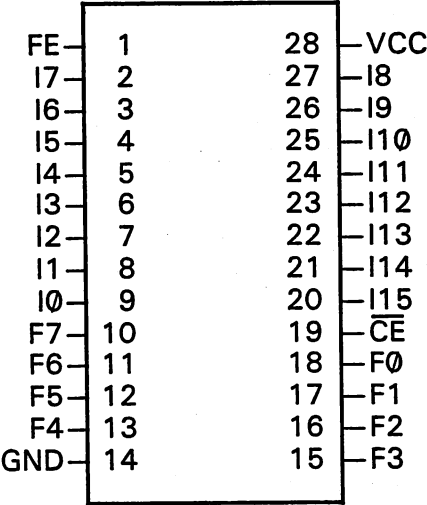
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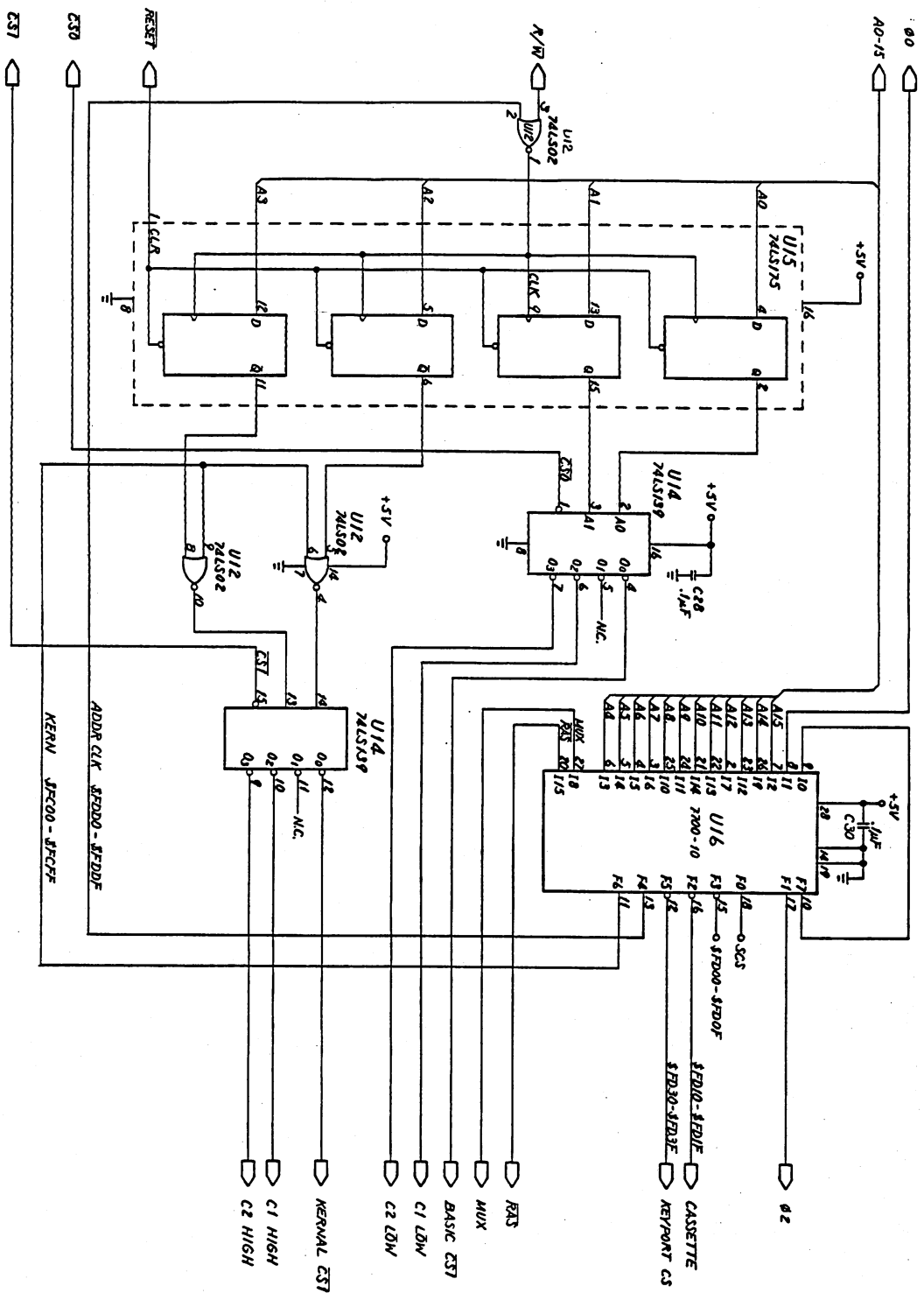
**U13-251640-03
SINGLE-PORT INTERFACE**

MOS	6529B	3 MHZ
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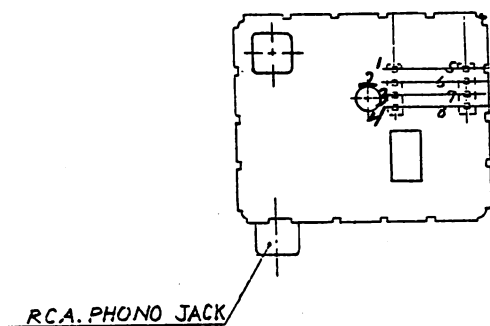
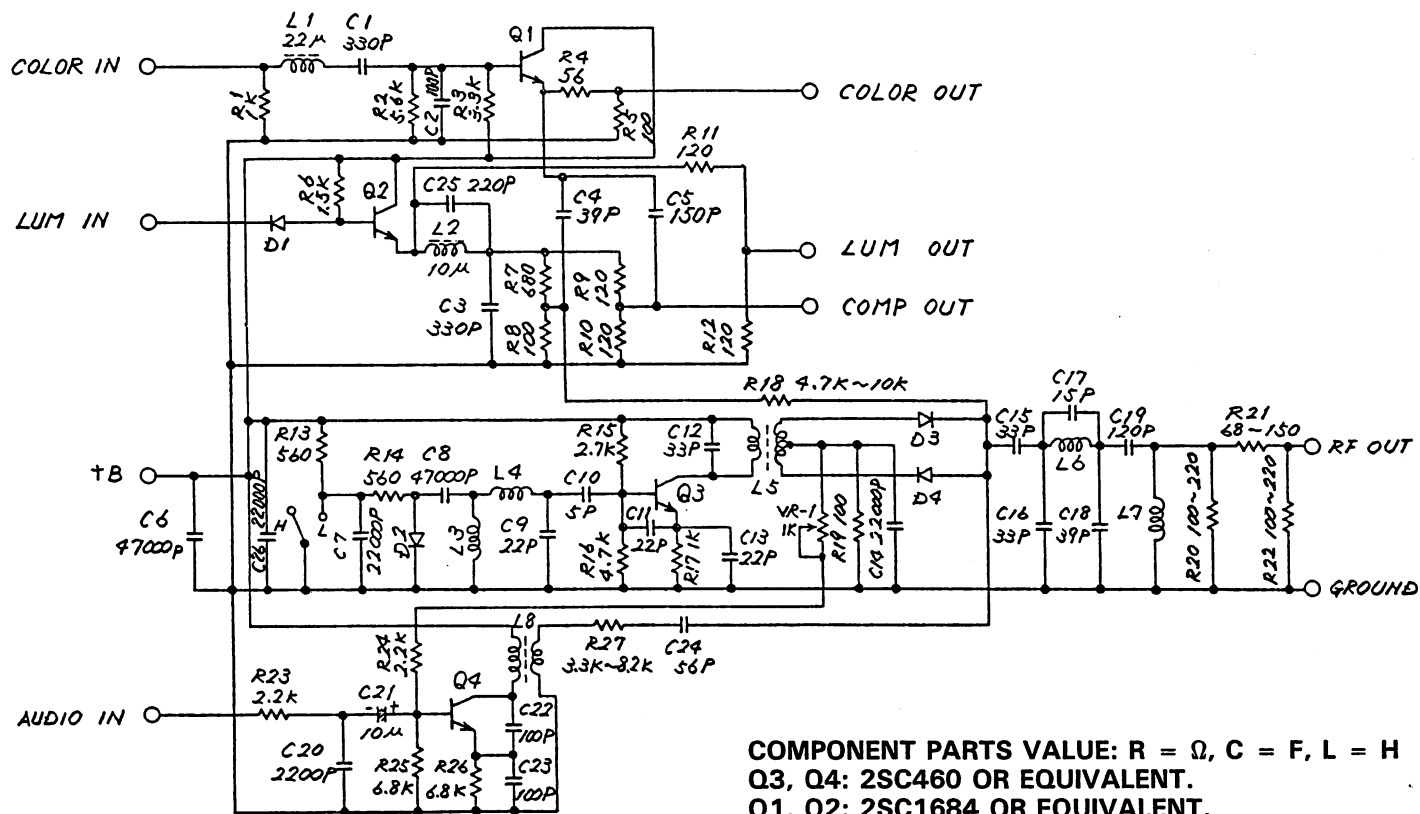
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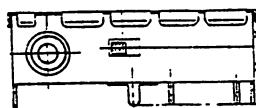
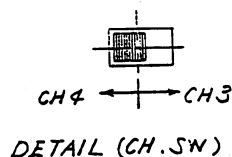
**U16-251641-02
PLA**



1. ALL RESISTANCE VALUES IN OHMS, 1/4W ± 5%.
 NOTES: UNLESS OTHERWISE SPECIFIED —



TOP VIEW



REAR VIEW

NO.	TERMINALS
1	N.C.
2	AUDIO SIG. INPUT
3	+B (+5V)
4	SYNC + LUM. SIG. INPUT
5	COLOR SIG. INPUT
6	COLOR SIG. OUTPUT
7	COMPO. SIG. OUTPUT
8	SYNC + LUM. SIG. OUTPUT
9	RF OUTPUT
10	CHANNEL SELECT SW.

RF Modulator Layout and Schematic #251844



Model: C16, PLUS 4

LINE DEFINITIONS

A0 to A15	Address Bit 0 to 15
AEC	Address Enable Control
ATN	Attention
BA	Bus Available
BRESET	Buffered System Reset
C1 HIGH, C1 LOW	External Cartridge Chip Select
C2 HIGH, C2 LOW	"
CAS	Dynamic RAM Column Address Strobe
CLK IN	Master Clock (Single Phase, 14.31818 MHz)
COLOR	Chroma Output
COMP	Composite Chroma and Luma
CE	Chip Enable
CS	Chip Select
CS0	Low ROM Chip Select
CS1	High ROM Chip Select
CST MTR	Cassette Motor Control
CST RD	Cassette Read
CST SENSE	Cassette Sensor
CST WRT	Cassette Write
CTS	Clear To Send
DB0 to DB7	Data Bit 0 to 7
DCD	Data Carrier Detect
DRAM	Dynamic RAM
DRAM ADD	Dynamic RAM Address
DSR	Data Set Ready
DTR	Data Terminal Ready
EXT AUDIO	External Audio Input
GATE IN	R/W GATE
IRQ	Interrupt Request
K0 to K7	Keyboard Latch 0 to 7
KERN	Kernal ROM Control Line
LUM	Composite Sync and Luminance
MUX	Address Multiplex Control
P0 to P7	Port Bit 0 to 7
RAS	Dynamic RAM Row Address Strobe
RESET	System Reset
RxC	Receive Clock
RxD	Receive Data
R/W	Read/Write Line
RTS	Request To Send
SND	Sound Line
TED	Text Display
TxD	Transmit Data
⚡ 0	System Clock (Varies between 1 and 2 MHz)
⚡ 2	Artificial ⚡ 2, Address Valid Rising Edge, Data Valid Falling Edge



Model: C16

Troubleshooting Aides

NOTE: Visual inspection is critical in this unit!
The upright position of many of the components used on the board can create problems. It is possible for them to be shorted to the shield or to each other. Make sure they are evenly spaced and do not contact the shield.

1) NO VIDEO - Absolutely no video on screen

A) Check for 5 volts

O.K.

If not:

- 1) Check fuse
- 2) Check for twisted or bent caps
(5 V. short to ground)
- 3) Check L1
- 4) Check 5 V. regulator
- 5) Check if top shield shorts to
+ 9 V. (Blown fuse)
- 6) Check if top shield is
shorting 5 V. to ground



B) Check for oscillation at pin 14 of U1

O.K.

If not: 1) Check for good connection at
pin 14 of U1



- 2) Check for good connection at
R1 thru R7

C) Check for LUM signal at pin 23 of U1, at pin 4 of
the modulator, at pin 8 of the modulator, at EM3
and at pin 1 of CN6

O.K.

If not: 1) Check for LUM signal shorted
to ground



- 2) Check for open traces
- 3) Check modulator

D) Check for reset

O.K.



E) Check for control signals:

Signal	I.C.	Pin
AEC	U1	35
AEC	U2	4
CAS	U1	11
CS1	U1	6
CS1	U14	15
CS0	U1	5
CS0	U14	1

Signal	I.C.	Pin
R/W	U1	7
0	U1	12
MUX	U1	9
IRQ	U1	8
RDY	U2	2
BA	U1	34
RAS	U1	10

2) BAD VIDEO - Scrolling lines on screen - Random blocks on screen - Blurred display

- A) Check U1 for proper operation
O.K. If not: 1) Check socket for good solder
↓ 2) Check for bad U1
- B) Check U2 for proper operation
O.K. If not: 1) Check socket
↓ 2) Check for bad U2
- C) Check RAM data lines for correct amplitude
O.K. If not: 1) Check for hot surface of RAM
↓ 2) Jump out RAM to verify
- D) Check multiplexers U7, U8 - signals at RP3 and RP4 should be similar in frequency and amplitude
O.K. If not: 1) Suspect U7 or U8
↓
- E) Check ROM for chip select signal at pin 22 of U3 and U4
O.K. If not: 1) Check for signal generation at U14
↓
- F) Check that all ROM addresses are present and correct amplitude
O.K. If not: 1) Trace problem address A0-A15
↓
- G) Check U16, U3, U4 by replacement with known good

3) NO POWER

- A) Verify voltage +5 and +9 volts
 - 1) Check for shorts to ground
 - 2) Check switch
 - 3) Check power supply

4) BAD BASIC - Random characters on screen - Random colors - Power-up message is missing

- A) Check Basic ROM U3
- B) Check A thru G above (Bad Video)

5) NO COLOR or BAD COLOR

- A) Check U1 pin 14 for 14.31818 MHz with frequency counter
O.K. If not: 1) Check solder joints of CT1 and adjust for correct frequency
↓ 2) Check crystal, Q1 and Q2
3) Check clock circuit for opens or shorts
- B) Check U1 pin 13 for Color Out signal.
O.K. If not: 1) Swap U1 w/known good
↓
- C) Check modulator M1 pin 5 for Color In signal and pin 6 for Color Out signal
O.K. If not: 1) Check M1 operation
↓
- D) Check EM4 and CN6 pin 6 to see if color signal is present.
1) Check for shorts

6) NO SOUND or BAD SOUND

- A) Check U1 pin 33 for SND signal
O.K. If not: 1) Check socket for open circuit
↓ 2) Swap U1 w/known good
- B) Check audio circuit for short to ground or loss of signal.
O.K. If not: 1) Check Q3 - Be sure emitter and base are not shorted to 5 V.
↓
- C) Check modulator M1 pin 2 for SND signal
1) Adjust I.F. can (top right of modulator) for clean, loud volume
2) M1 pin 2 to ground should read approximately 480 ohms
3) Check M1 for component failure

7) SERIAL FAILURES

- A) Check FB14-19 for shorts to shield or each other (has caused serial port problems)
B) Check FB1-5 for shorts to shield or each other
C) Check U9, U2 and CN7